PATENT SPECIFICATION

DRAWINGS ATTACHED

849,255

Date of Application and filing Complete Specification Oct. 25, 1957.

No. 33379/57.

Application made in Czechoslovakia on Nov. 1, 1956.

Complete Specification Published Sept. 21, 1960.

Index at acceptance:—**Class 51(1), A1B1X, B9A.**

International Classification:—**F02c, F23f.**

COMPLETE SPECIFICATION

Method of and Arrangements for Cooling the Walls of Combustion Spaces and other Spaces Subject to High Thermal Stresses

I, JOSEF CERMAK, of 20, M. Cibulkove, Prague XV, Czechoslovakia, a Czechoslovak Citizen, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention relates to a method of and to arrangements for cooling the walls of combustion spaces and other spaces subject to high thermal stresses, such as combustion chambers, melting chambers and the like.

It is an object of the present invention to provide a highly efficient cooling system for the walls of such spaces so that the cooling is adjustable locally according to the magnitude of the thermal stress, and the cooling is effected with a small amount of a gaseous or liquid cooling medium with the smallest possible consumption of energy for the circulation of the coolant.

Arrangements for cooling the walls of small combustion chambers in combustion turbines for aircraft, land vehicles, or the like are known. In order to reduce the weight and dimensions, the walls of such combustion chambers have a small thickness and are made of fire-resistant metals. However, the metal walls must be cooled in operation, because the combustion temperatures in the interior of the chamber are higher than the melting temperature of the metal forming the wall. A part of the combustion and dilution air is used as cooling medium. The air heated in this way is then used for the combustion of the fuel.

Air cooling is carried out in principle by leading first the air along the metal walls, which are to be cooled; during this process the air is heated, whereupon it enters the combustion space. The admission of the heated cooling air into the combustion space is carried out in various ways according to circumstances. This may be effected either through a system of circular apertures, or in the case of a so-called "film-cooling" through narrow slots which are provided in planes perpendicular to the axis of the combustion chamber. Also known is an arrangement with outer cooling of the combustion chamber wall in which the cooling air is guided towards the outer surface of the wall of the combustion chamber by means of a system of inlet and outlet channels provided in a supporting outer shell which surrounds the combustion chamber wall.

With these known methods it is possible to cool metal walls of combustion chambers only where, on the one hand, there is a sufficient amount of cooling air available and, on the other hand, where the thermal stress of the walls is relatively low. This is the case in the above-mentioned combustion chambers of combustion turbines, which are actually miniature devices in which the flame radiates to a relatively small extent against the metal walls, apart from the fact that owing to the small dimensions, the temperature in the interior of the combustion chamber is relatively low.

In connection with combustion plants of boilers, industrial furnaces or the like, the described process for the cooling of metal walls cannot be employed. The reason is that in such plants a minimum amount of coolant must suffice, for example one third to one fourth of the air, which may be used in combustion chambers of combustion turbines and the air is already partially preheated. Moreover, the efficiency of this process is here not sufficient for proper cooling of the walls, because the heat withdrawal takes place through a thick boundary layer of air produced in this case.

The present invention removes or substan-

[Price 3s. 6d.]

tially reduces the drawbacks and disadvantages of the known arrangements for cooling the walls of combustion spaces and other thermally highly stressed spaces. According to the present invention a method is provided of cooling walls of combustion spaces or other thermally highly stressed spaces by means of a cooling medium, wherein the cooling medium is admitted to the outer side of the wall through jet-forming nozzles arranged substantially at right angles to the wall, and wherein the heated cooling medium is immediately withdrawn from the cooled wall.

A further feature of the present invention is to supply the coolant through nozzles which are formed by the cooled wall members. In order to achieve a particularly high cooling efficiency, the said members may be carried out in such a manner that the nozzles project into preferably cylindrical cooling pockets, which are arranged at the outer faces of the wall members. These pockets are formed by projections at the outer side of the wall members, the jets of the coolant issued by the nozzles striking against the bottom of the projection.

The mentioned features, by which the present invention is distinguished from the hitherto known cooling methods, offer a number of advantages, the following being the most important:—

1. A sufficient cooling effect may be achieved even at high temperatures and with a minimum amount of a gaseous or liquid coolant.

2. The cooling can be adjusted in a simple manner according to the local thermal stresses of the walls by a varying density of the nozzles and their suitable combination with the cooling pockets arranged in the wall.

3. The cooling medium flows at a high velocity at the points of cooling only, i.e., in the nozzle and its closest surroundings, whereas in the other parts of the system, i.e., in the inlet and outlet channels, it flows slowly and therefore also with comparative small pressure losses; the whole system operates therefore with considerable savings in conveying energy.

In comparison with known arrangements, the present invention meets therefore in a satisfactory way the requirements placed on the cooling of walls, not only in relatively small combustion devices for turbines, but in particular in combustion plants for boilers, industrial furnaces and the like.

The accompanying drawing represents by way of example two cooling members, which operate on the principle according to the present invention.

Fig. 1 shows in a sectional view a simple arrangement with a smooth cooled wall,

Fig. 1A is a similar sectional view taken in a different plane,

Fig. 2 represents a combination of nozzles with cooling pockets in a sectional view along the line II—II in Fig. 3 and

Fig. 3 is the corresponding plan view.

The corresponding parts are marked with identical references in all figures.

The wall 1 (Fig. 1 and 1A) which defines a combustion space or other thermally highly stressed space is divided into individual cooled wall members. Each member forms at its outer side a collecting chamber 6 and at its inner side a distribution chamber 4, both chambers having either an independent inlet or outlet for the cooling medium respectively. In the example shown it is the inlet 2 and the outlet 3 for the coolant. The latter acts on the wall 1, to be cooled, by means of several concentrated jets emerging from nozzles 5.

The nozzles 5 are attached to the distribution chamber 4 for the coolant. The cooling medium which strikes the cooled wall 1 at a relatively high velocity substantially at right angles, is collected in the collecting chamber 6 and withdrawn through the outlet 3 from the wall member.

Owing to the impact of the jet against the wall, the influence of the boundary layer is eliminated or, at the utmost, only a thin boundary layer can be formed. The heated coolant is immediately collected and removed from the cooled member. The cooling medium flows with a high velocity in the nozzles only. In other parts of the cooled member it flows through relatively large cross-sectional areas and therefore with a relatively low velocity and small pressure losses. At points, where the metallic partition is subject to high temperatures, it is made of a heat-resisting metallic material.

Fig. 2 shows the metallic partition 1 of the combustion or other thermally highly stressed space provided with cylindrical cooling pockets, the latter forming projections at the inner side of the wall 1. The cooling pockets 7 are also made of a heat-resisting metallic material at the points, where they are subjected to high temperatures. The cooling pockets 7 are lined with a heat-resisting thermally insulating material 8.

The nozzles 5 which are connected to the distribution chamber 4 for the coolant protrude into the cooling pockets 7. The outflowing coolant strikes at a relatively high velocity the bottom of the cooling pocket 7 in a similar manner as in the first quoted example. The cooling medium flows from the cooling pocket 7 immediately into the collecting chamber 6, from where it is withdrawn through the outlet 3 for further use, e.g., as combustion supporting medium.

Owing to the arrangement of the distribution chamber 4 for the fresh coolant on the outside of the collecting chamber 6 for the heated coolant, the thermal losses to the out-

side are thus reduced in a simple way to a small value even when the outer surface is not insulated.

The cooling intensity may be adjusted according to the local intensity of the thermal current so as to avoid the admissible highest temperature of the part subject to the highest thermal stresses, i.e., for example the bottom of the cooling pocket 7, from being exceeded. This is effected by the choice of a suitable density of the cooling pockets 7 and the corresponding nozzles 5 per unit of area.

It is also possible to utilise the insulating effect of the molten slag, and the cooling pockets 7 may then be spaced further apart. This advantage cannot be used at all in a process in which the heated cooling air is admitted directly into the combustion space, because the channels for the passage of air would become clogged with slag. In the process according to the present invention the cooling intensity of the metal wall may also be altered by a variation in the amount of the supplied cooling medium.

In the preceding disclosure the advantages have been stressed which are obtained by using the present invention for cooling the metallic walls of combustion spaces. The employed new principle offers, however, the possibility also to cool walls, which are made of another material than metal. The wall need not even define a combustion space and the invention can be applied similarly to say other spaces containing a medium of such a high temperature as cannot be withstood by any technically available material.

WHAT I CLAIM IS:—

1. A method of cooling walls of combustion spaces or other thermally highly stressed spaces by means of a cooling medium, wherein the cooling medium is admitted to the outer side of the wall through jet-forming nozzles arranged substantially at right angles to the wall, and wherein the heated cooling medium is immediately withdrawn from the cooled wall.

2. An arrangement for carrying out the method according to Claim 1, wherein the wall of the combustion space or other thermally highly stressed space is divided into individual cooled members, wherein each cooled member forms at its outer side a collecting chamber followed, in the direction of flow of the cooling medium, by a distribution chamber, wherein the distribution chamber is provided with nozzles opening into the collecting chamber and pointing towards the bottom of the collecting chamber which is at the same time the outer face of the cooled wall member, and wherein the distribution chamber is provided with an inlet for the cooling medium and the collecting chamber is provided with an outlet for the cooling medium.

3. An arrangement according to Claim 2, wherein the bottom of the collecting chamber, which is the outer face of the cooled wall member, is provided with projections which form pockets, and wherein the said nozzles of the distribution chamber extend into the said pockets towards the outer face of the cooled wall member.

4. An arrangement according to Claim 3, wherein the cooling pockets are of cylindrical shape.

5. A method of cooling walls of combustion spaces or other thermally highly stressed spaces by means of a medium admitted in individual jets striking the wall substantially as hereinbefore described.

6. Arrangements for cooling walls of combustion spaces or other thermally highly stressed spaces substantially as hereinbefore described with reference to and as illustrated in Figs. 1 and 1A and Figs. 2 and 3 in the accompanying drawings.

For the Applicant:
MATTHEWS, HADDAN & CO.,
Chartered Patent Agents,
31—32, Bedford Street, Strand,
London, W.C.2.

Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press.—1960.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained

849,255 COMPLETE SPECIFICATION

1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

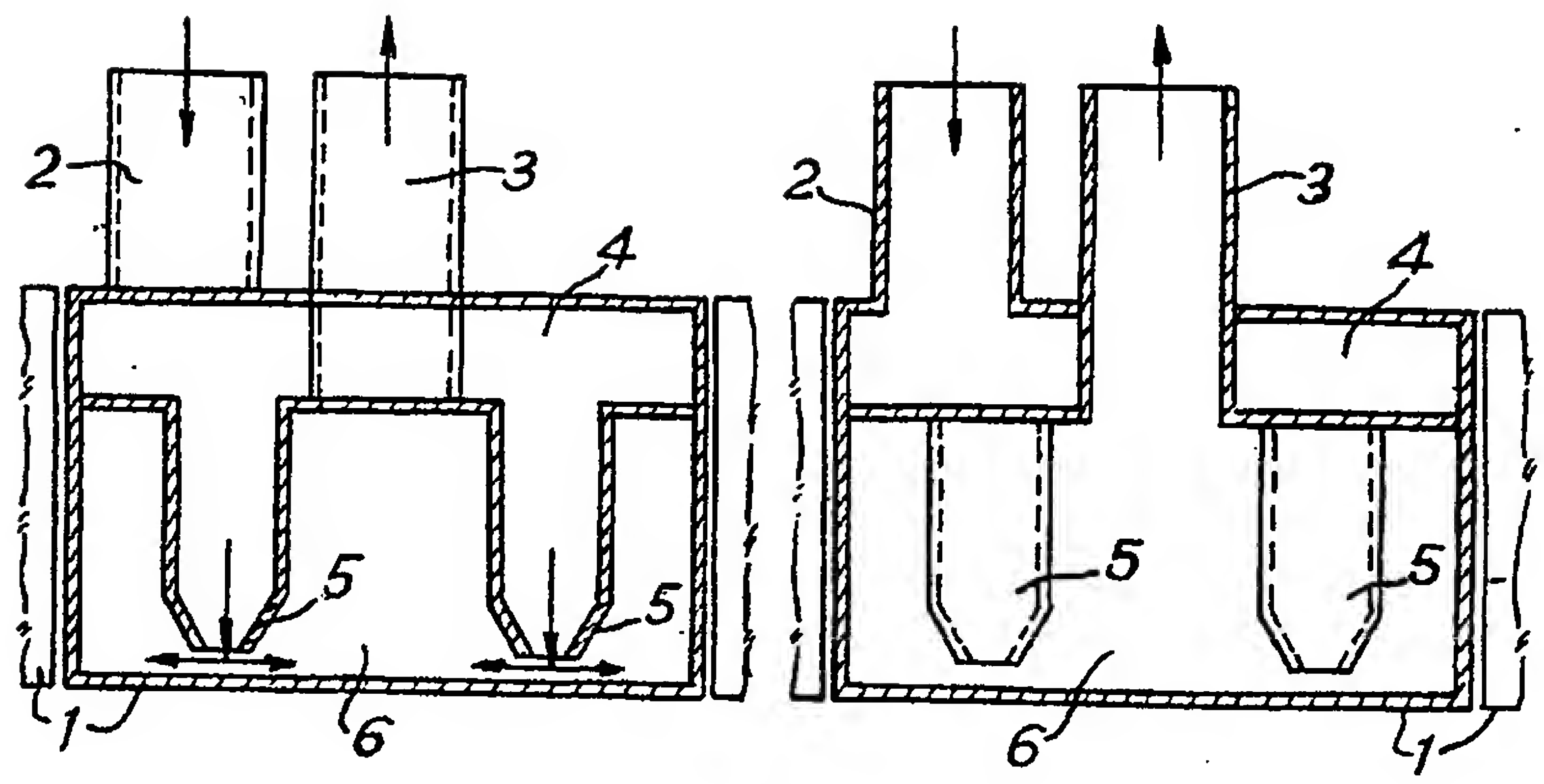

FIG. 1.   FIG. 1A

FIG. 2.

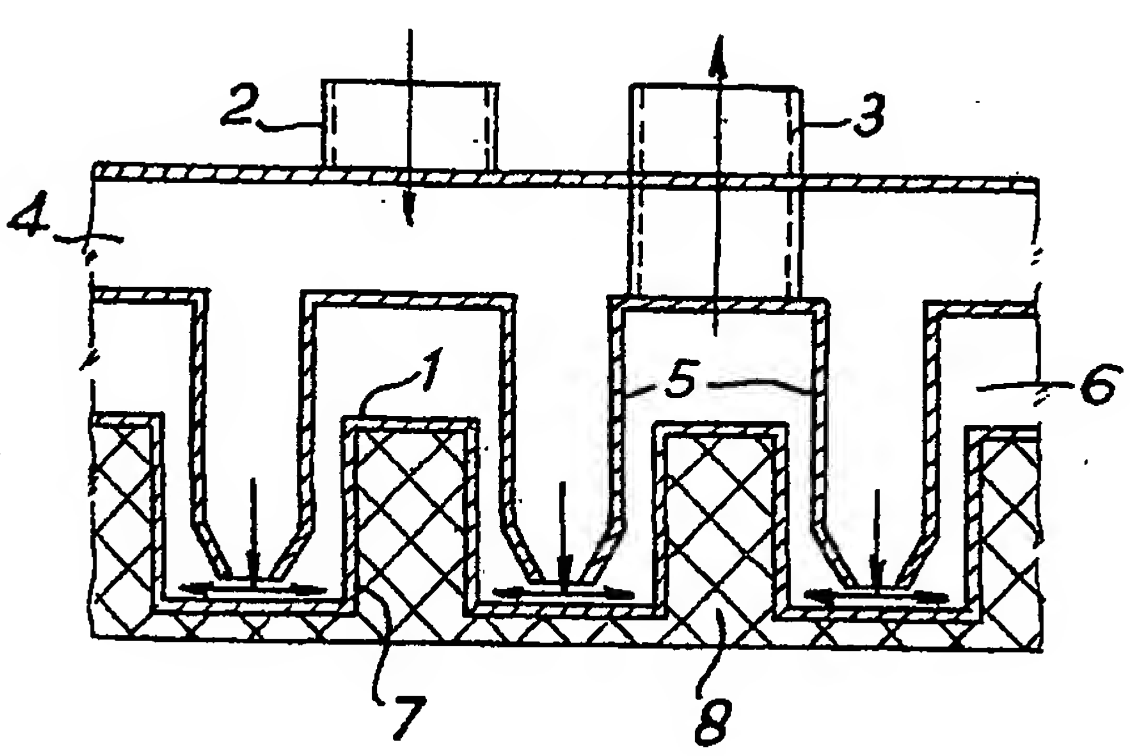

FIG. 3.